

Camouflaging Vehicles Using Field Expedient Materials, Commercial Hardware Store Materials, Camouflage Nets, and Rubber Conveyor Belt Material

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Analysis of FLIR Imagery of Field expedient Camouflage Systems on US Army Vehicles

In June of 2001, the US Army CERDEC NVESD camouflaged several vehicles for a FLIR field test at a wooded US Army test site in the western United States. The vehicles were camouflaged using field expedient camouflage materials, commercial hardware store materials, and standard camouflage nets. The camouflage materials were augmented with pieces of rubber conveyor belt material as observed being used on tanks in Serbia and Bosnia. The camouflage was placed on 3 US vehicles and Long wave FLIR imagery was collected at various ranges. The effectiveness of the camouflage treatments was analyzed.

1.0 PROGRAM SUMMARY

This program began based on pictures obtained in Bosnia and Serbia that showed that the Serbian and Bosnian Armies were covering their T-55 tanks with camouflage netting and a rubber material, determined to be conveyor belt material from local sand and gravel pits.

The Serbians and Bosnians were claiming that the material suppressed the thermal signature of their T-55 tanks. This claim, if true, could make them harder than standard tactical vehicles to detect and target with infrared sensors.

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Figure 1a and 1b Bosnian and Serbian Mobile camouflage

In order to make a determination as to the effectiveness of this approach to thermal camouflage, a field test was conducted to collect short and long-range thermal infrared imagery. Advanced FLIR systems were used to collect imagery of various types of military vehicles with and without simple mobile camouflage measures. The data would be used to analyze the effectiveness of the camouflage on sensor performance. The camouflage techniques to be tested were field expedient and depot level materials, augmented with the Serbian/Bosnian style conveyor belt materials and standard camouflage netting.

2.0 TEST DEVELOPMENT

The test was conducted at a US Army test site in the western United States. The terrain is a natural combination of heavy woodland and meadows, rolling small mountains and hills. The sensors were located on top of a small mountain providing some elevation, as shown in Figure 2, and the targets were positioned down

range at various distances starting at 1 km and going out to 8 km. The target locations were marked and staked using GPS positioning and one of the FLIR systems was utilized with which it was determined that each target at each location was detectable.

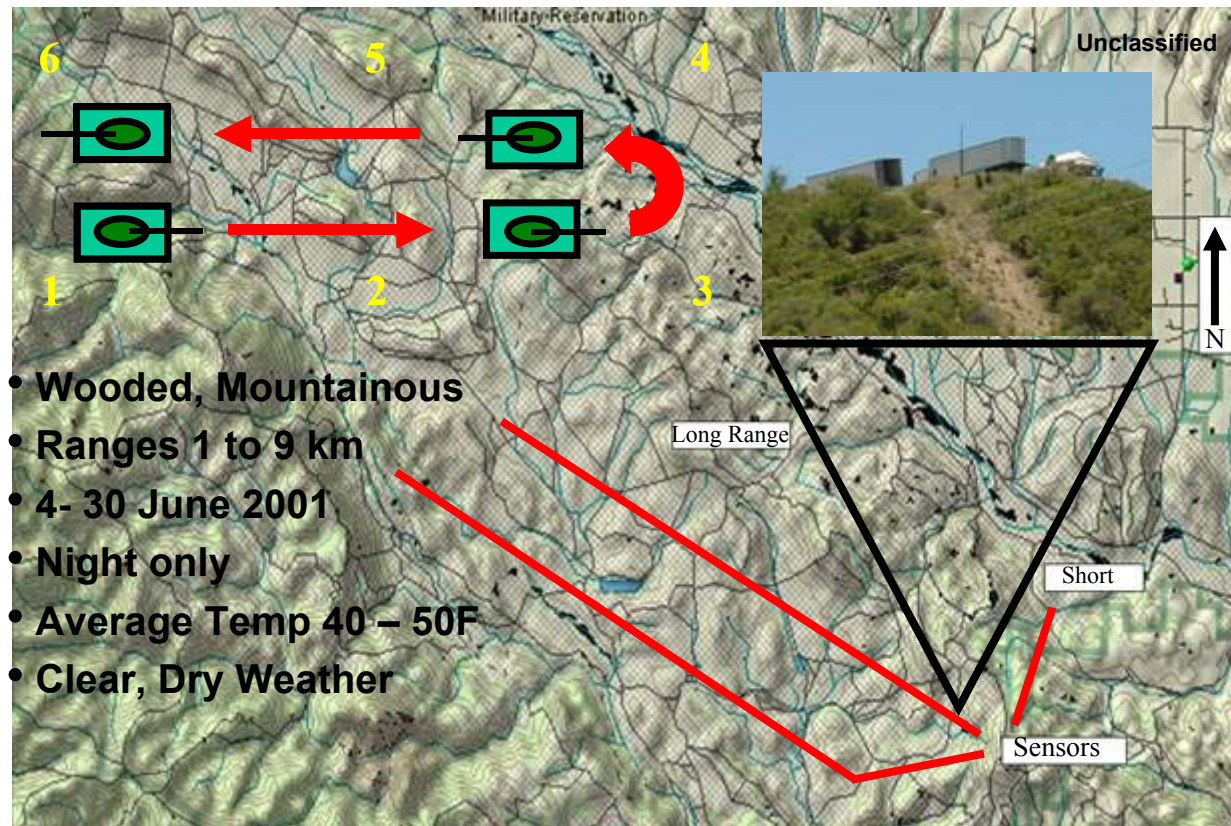


Figure 2. Sensor Location and Target Range

Normally two (2) locations were established for each distance, one in the open and the 2nd against a tree line. Two (2) stake positions were located at each range position separated by about 100 meters, for example position 7A and 7B. The second stake or B stake was separated from stake A by a distance of 110 m or approximately the distance that could be travelled at 10 km/h in 20 seconds. The vehicle was moved into position A and measurements were taken, then the vehicle travelled to position B. Infrared images were taken as the vehicle moved from A to B at 10 km/hr. The vehicle would then stop at stake B and additional imagery was taken. The vehicle would then turn 180 degrees and the test sequence would be repeated for the opposite side of the vehicle. The vehicle is usually imaged from both sides because the vehicle is usually not identical on the left and right side. For example, the LAV 25 has the engine exhaust on the right side; therefore, the right side is considerably hotter than the left side.

3.0 SENSORS

The sensors used in this test, see Figure 3 and 4, were an NVESD Long wave FLIR which is an 8-12 micron FLIR system with a 6" lens, 480 horizontal lines, the Amber FLIR which is a 3-5 micron FLIR camera, the Agema FLIR which is a calibrated 8-12 micron camera, the standard Army 1st Gen FLIR system which is an

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8-12 micron system with a 1st Generation detector with 120 detector elements, and an Army Research Laboratory (ARL) Two Colour FLIR which is a 256x256 line pixel registered 3-5 and 8-12 micron FLIR system with both detectors on the same focal plane array. All of these sensors have been configured to record their imagery in real time on high-speed hard disk drives.



Figure 3 and 4. NVESD Agema Calibrated FLIR, Amber FLIR and the inside of the NVESD Sensor Trailer.

Figures 3 and 4 show the inside of the NVESD sensor trailer. Figure 5 is a picture of the ARL 2-color FLIR that was mounted on a separate trailer. It shows some of the test range terrain in the background.



Figure 5. Army Research Laboratory 2 Color FLIR and terrain

4.0 CAMOUFLAGE TECHNIQUES

The following vehicles were used in the entire field test: M2A2 Bradley, LAV-25, HMMWV, T-72, BMP, BTR-70, BTR-80, and a BRDM. The camouflage part of the field test used 3 vehicles, the M2A2 Bradley, LAV-25, and a HMMWV, see Figure 6. The LAV-25s were provided by the US Marine Corps.



Figure 6. Bare M2A2 Bradley Infantry Fighting Vehicle, bare LAV-25, and bare HMMWV.



Figure 7 and 8. HMMWV with thermal insulation, camouflage netting, and conveyor belt material

Pictures of some of the vehicles, and camouflage treatments that were tested, are as shown in Figures 6, 7, 8, 9, and 10. These were referred to as bare, field expedient camouflage (FE), and depot level camouflage (DLC). The FE camouflage was a sample of what a unit in the field could be expected to do with some camouflage netting, wire, and conveyor belt material. The depot level camouflage was somewhat more extensive, and was an example of what could be done with access to common construction materials available at depot or depot level warehouse.

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The HMMWV depot level camouflage, Figures 7 and 8, used double layers of aluminized bubble wrap insulation with camouflage netting and the conveyor belt material over the wheel wells and grill.



Figure 9a and 9b. M2A2 Bradley with depot level camouflage - conveyer belt over the vehicle surface augmented by a Colebrand (UK) Solar Blanket, and 2 types of US Camouflage Nets, the LCSS (Lightweight Camouflage Screen System) and ULCANS (Ultra Lightweight Camouflage Net System)

Figure 9 shows the M2A2 Bradley with depot level camouflage. First the conveyer belt material was placed on the vehicle. Holes were drilled into the rubber mat and the pieces were held in place with standard copper

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electrical wire. Colebrand (UK) thermal solar covers purchased by PM-Bradley were installed on the turret and deck. Finally pieces of the 2 camouflage nets, the LCSS and ULCANS were draped over the vehicle.



Figure 10 and 11. Depot level camouflage on the LAV-25 consisting of conveyer belt material over the wheels, pieces of ULCANS camouflage netting over the vehicle and with an insulated wooden box over the engine air intake area.

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Figures 10 and 11 show a similar installation of camouflage on the LAV-25, except that no Colebrand solar covers were available or installed on this vehicle. In Figure 11, the conveyor belt material was used to cover the top of the wheels and the wheel hubs that get hot when in operation.

5.0 IMAGERY

The following pictures show short-range (1000 meters or less) night time infrared imagery of these targets. All the images shown are AGEMA Long Wave FLIR wide field of view (WFOV) imagery.

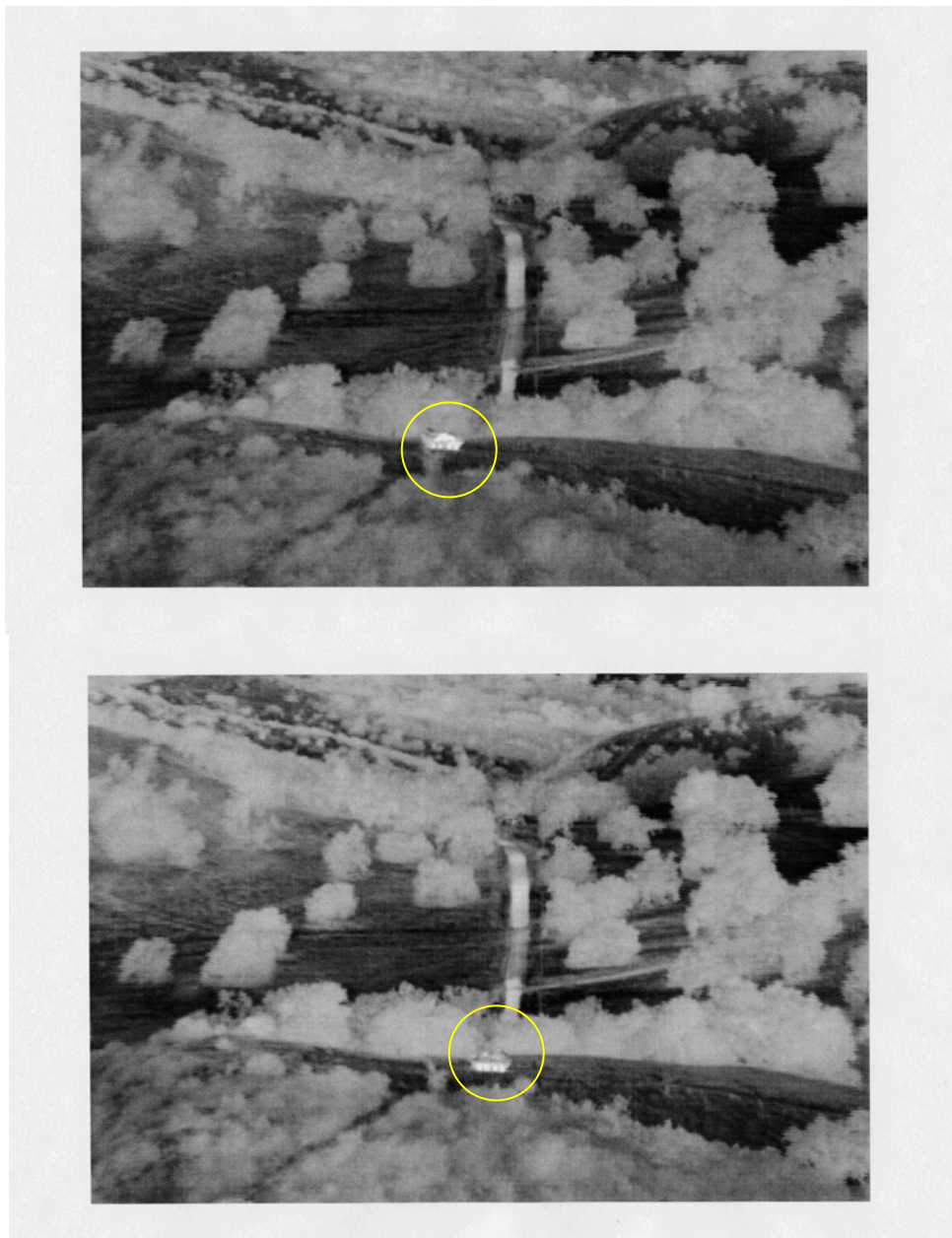


Figure 12. Long Wave FLIR image, Bare LAV, Right Side/Left Side

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Figure 12 is a Long Wave FLIR image of the bare LAV in WFOV. The vehicle is stationary, the range is 1 km. The right side has the hot exhaust and there is no camouflage. Notice that the vehicle is easily detectable with the turret and hull discernable.

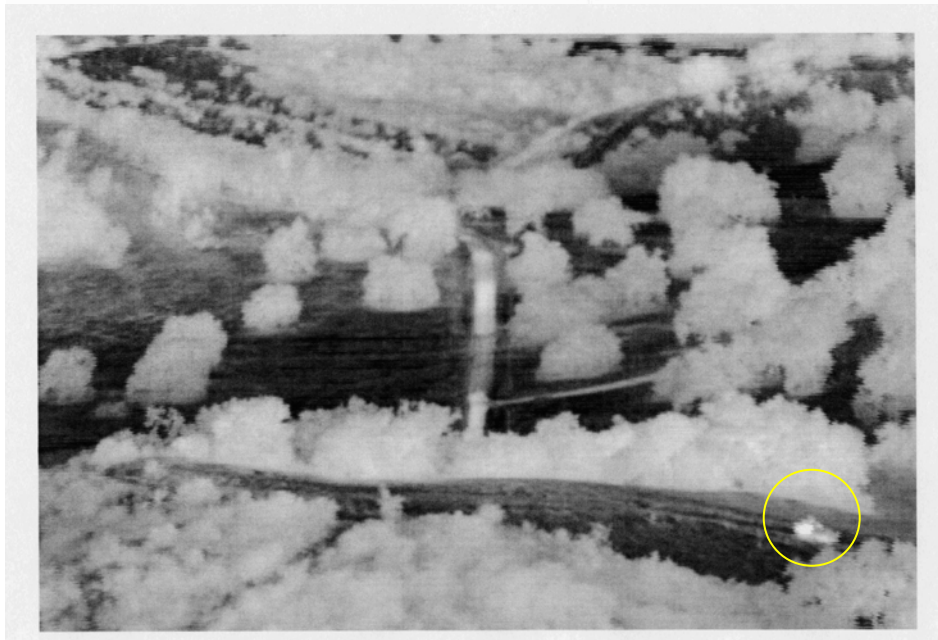
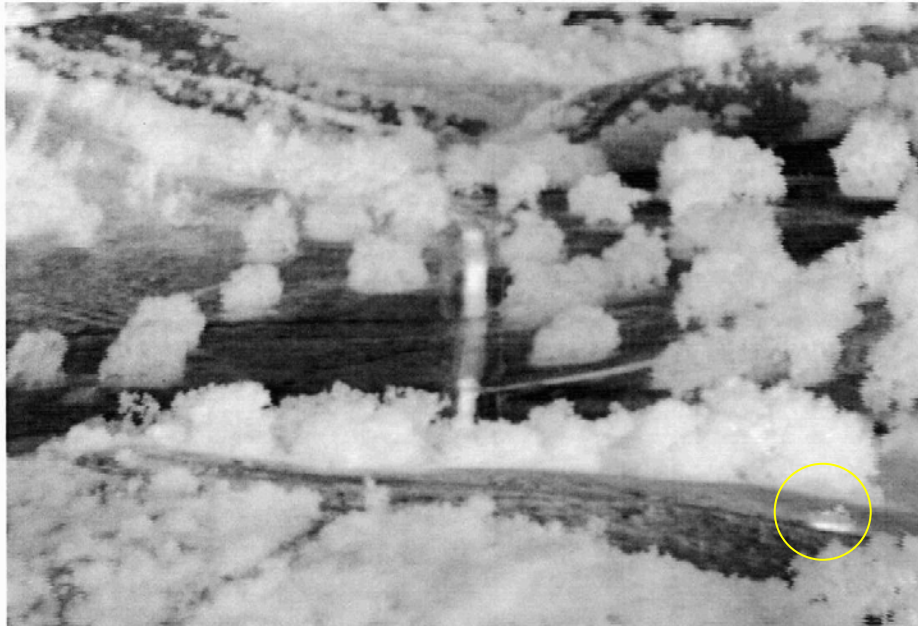


Figure 13. Long Wave FLIR image, LAV-25, Left Side/Right Side, with depot level camouflage

Figure 13 shows the Non-exhaust (left side) and hot exhaust side (right side) of the LAV-25 at 1 km. The LAV-25 has depot level camouflage. Part of the vehicle is thermally hidden. The hull and turret are not easily

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discernable. The depot level camouflage helps to reduce the thermal signature but does not eliminate it. The hot exhaust is detectable and defeats the attempt at thermal camouflage.

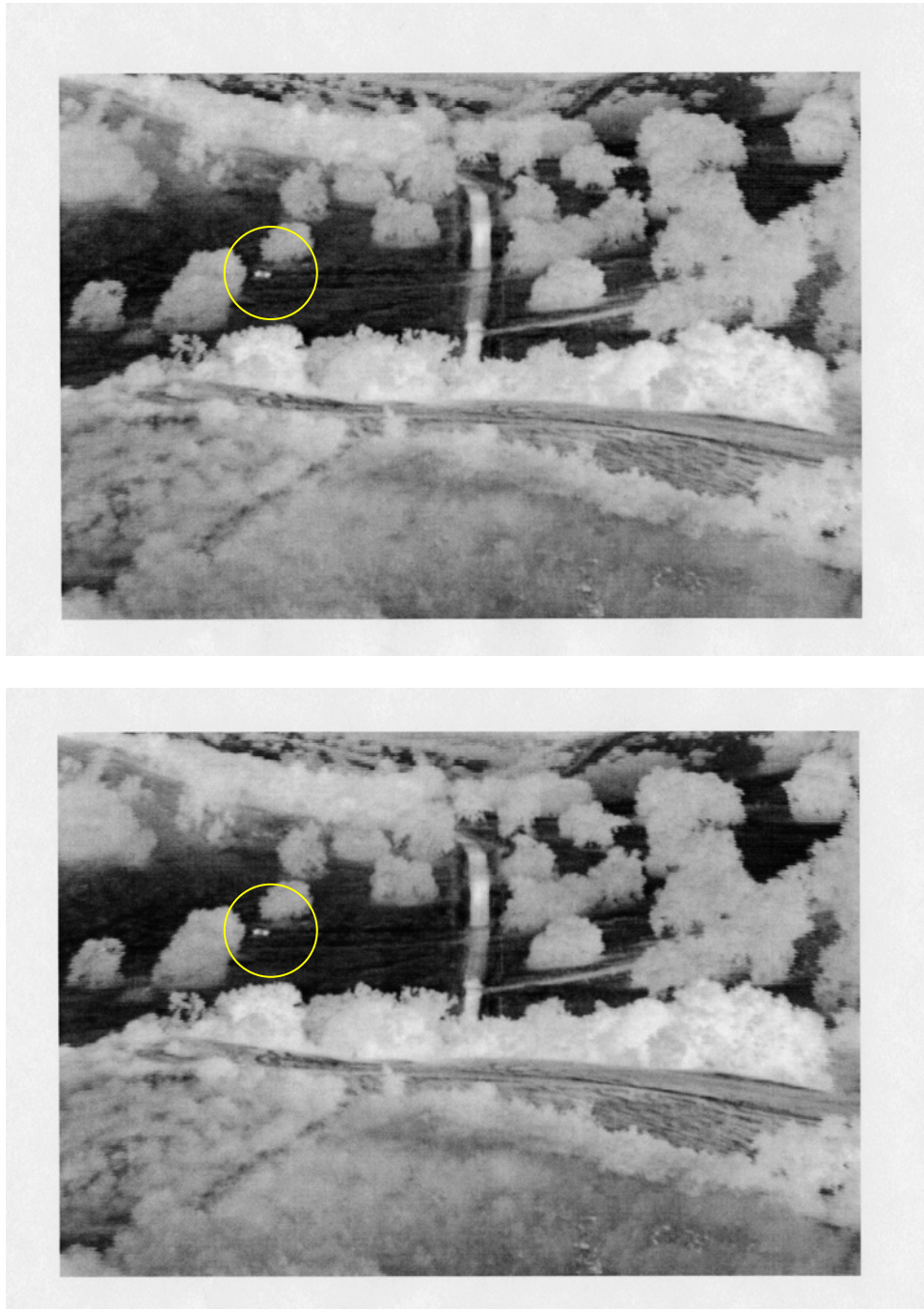


Figure 14. Long Wave FLIR Image of Bare HMMWV, Right/Left side, 1 km

Figure 14 has the depot level camouflaged HMMWV located inside the circle. In general, the HMMWV target is the most difficult to detect of the three targets because it is the smallest target. The vehicle signature is essentially the same on the left and the right side.

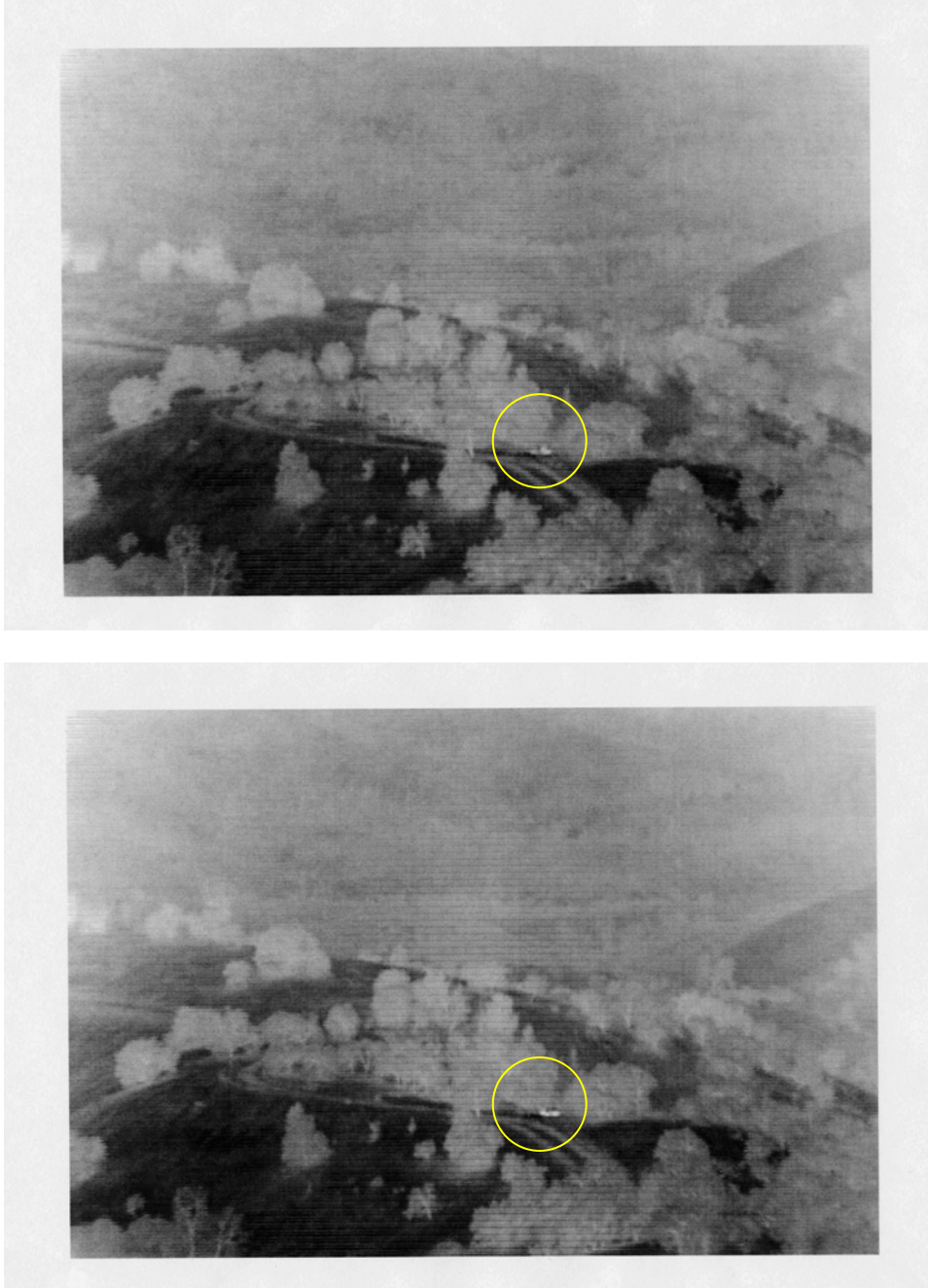


Figure 15. Long Wave FLIR Image of Depot Level HMMWV, left/right side, 1 km.

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Figure 15 Shows the HMMWV with depot level camouflage as described above. The camouflage further reduces the target signature and makes detection of the stationary vehicle more difficult. It is detectable in the narrow field of view; however, the search time may be considerably longer.

6.0 OBSERVATIONS

These simple low cost camouflage techniques resulted in making the vehicle targets more difficult to detect, through the Long Wave FLIR system using the wide field of view.

The conveyor belt material is rugged and can survive field use.

The conveyor belt material is successful in reducing the infrared signature cues from the tracks, tires and wheel hubs. This type of camouflage may be even more effective in cold and wet weather conditions.

This camouflage is simple to use and easy to install. Its effectiveness is enhanced if the installation crew has a FLIR camera available to verify that the camouflage is hiding all the very hot parts, such as the engine exhaust, engine intake, tracks, road wheels and wheel hubs. On-site personnel reported that the conveyor belt material reduced the sound level of the test vehicles. Sound measurements are planned with and without the conveyor belt camouflage.

Field expedient camouflage with camouflage netting is only effective if the hot spots can be eliminated. The use of pieces of camouflage netting helps in camouflaging the vehicle.

Field expedient and depot level camouflage is within the technological capability of practically any 3rd world country.





US Army RDECOM CERDEC Night Vision and Electronic Sensors Directorate

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Background

This program began based on pictures obtained in Bosnia and Serbia that showed that the Serbian and Bosnian Armies were covering their T-55 tanks with camouflage netting and a rubber material, determined to be conveyor belt material from local sand and gravel pits.

The Serbians and Bosnians were claiming that the material suppressed the thermal signature of their T-55 tanks. This claim, if true, could make them harder than standard tactical vehicles to detect and target with infrared sensors.



Serbian and Bosnian Tanks



Unclassified

Serbian Conveyer Belt Camouflage

Claims of Infrared Signature
Suppression,
Acoustic Suppression,
and
pre-ignition of RPG munitions



Unclassified



Serbian Style Camouflage



Unclassified

**Serbian style
camouflage on
BMP-2 at US
Test Facility
Conveyer Belt
material and US
Camouflage Net**



Unclassified



Foreign Mobile Camouflage Systems



Russian Stalker

Unclassified



Unclassified

**Russian Nakidka
Camouflage Kit**

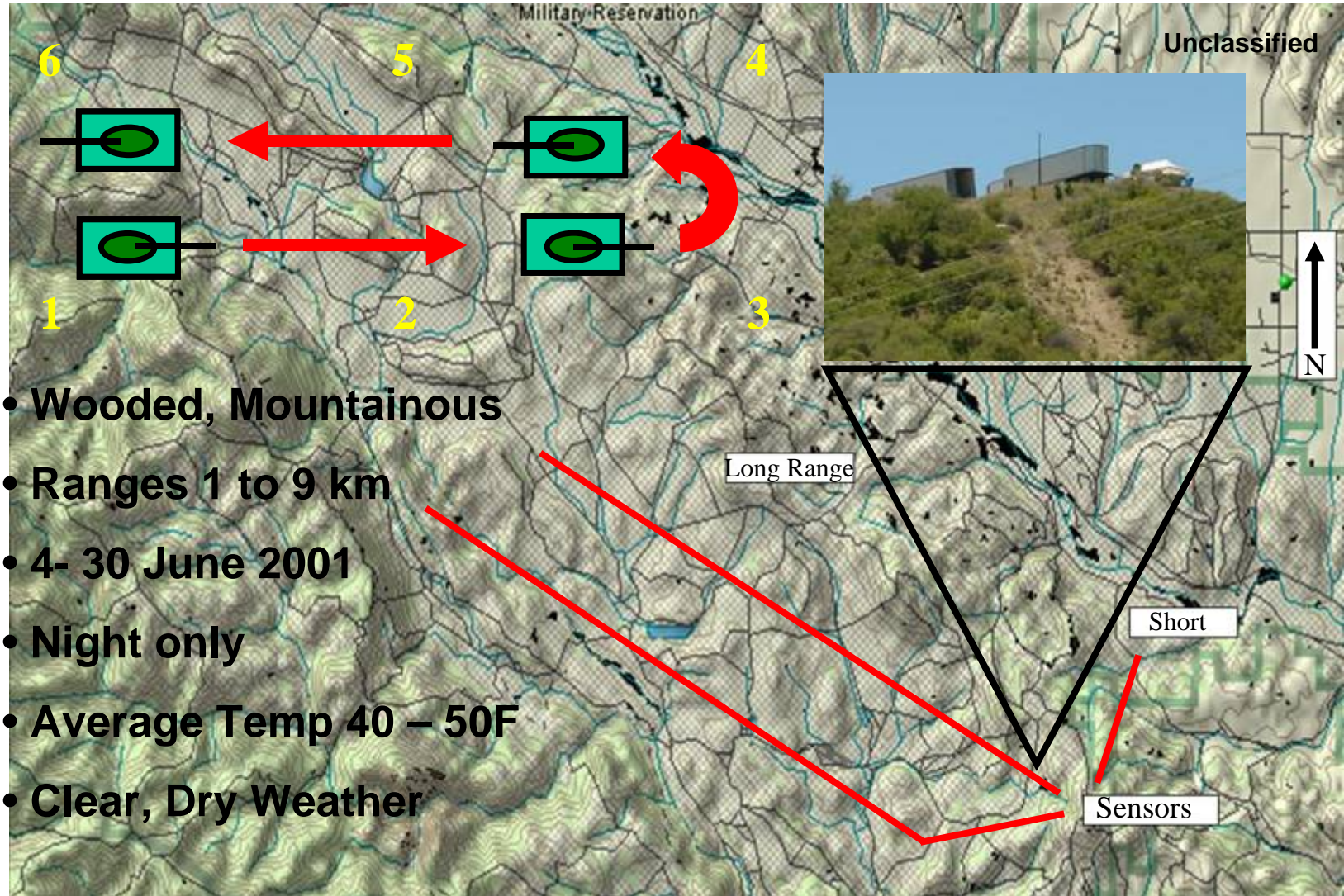


Purpose

- To collect Thermal Infrared Imagery with Advanced FLIR Systems of Military Vehicles with and without Simple Mobile Camouflage measures to analyze their effectiveness on sensor performance.
- Devise camouflage techniques to include the use of Serbian/Bosnian style conveyor belt materials, field expedient and depot level maintenance materials, along with standard US camouflage netting.



Terrain





Sensors

Sensors Suite

NVESD Long Wave (8-12 microns)

NVESD Amber FLIR (3-5 microns)

NVESD Agema FLIR (8-12 microns - Calibrated)

ARL Long Wave – Mid Wave Registered



UNCLASSIFIED/UNLIMITED



NVESD FLIRS

Amber, Agema FLIR and NVESD Sensor Control Van



UNCLASSIFIED



UNCLASSIFIED/UNLIMITED



ARL FLIR

3-5 and 8-12 FLIR - Pixel registered on the Focal Plane



UNCLASSIFIED



Targets and Camouflage Techniques

The following vehicle types were used in the field test: T-72, BMP, BTR-70, BTR-80, BRDM, M2A2 Bradley, LAV-25, and a HMMWV.

Camouflage test used M2A2 Bradley, LAV-25, HMMWV

Bare (uncamouflaged) and Camouflaged with:

Field Expedient (FE) Camouflage

Depot Level Camouflage (DLC)



UNCLASSIFIED/UNLIMITED



3 Vehicles – Bare (Uncamouflaged)

M2A2 Bradley



Unclassified



Unclassified

HMMWV



UNCLASSIFIED



M2A2 Bradley with UK Colebrand Solar Kit (U)





UNCLASSIFIED/UNLIMITED



M2A2 Bradley with Conveyer Belt Material, UK Colebrand Solar Kit, and US LCSS and ULCANS Camouflage Nets



Unclassified



Unclassified

UNCLASSIFIED



LAV-25 Standard LAV-25 Depot Level Camouflage



Unclassified

Standard LAV-25

**Muffler exhaust cover,
wheel hub covers and
ULCANS Camouflage**



Unclassified



UNCLASSIFIED/UNLIMITED



LAV-25 Camouflaged – depot level camouflage, hub camouflage, and ULCAN Camouflage Nets



UNCLASSIFIED



LAV-25 Camouflaged with conveyer belt material, depot level camouflage, and US ULCANS Camouflage Nets

Unclassified





HMMWV – Depot Level Camouflage



Unclassified

Double layer of bubble wrap sandwiched between aluminum foil

Bubble wrap covered with camouflage netting and rubber mat material over wheels



Unclassified



Imagery

The Following charts show thermal imagery of the bare and camouflaged HMMWV and LAV-25. Due to space and time limitations the M2 Bradley is not shown, however results are similar to the LAV-25.

All imagery was taken with a commercially available AGEMA 1000LR 8-12 Micron FLIR using the wide field of view. Collection was night, ranges 1000m or less.



LAV-25

AGEMA FLIR Imagery, No Camouflage, Right Side, 1 KM





LAV-25

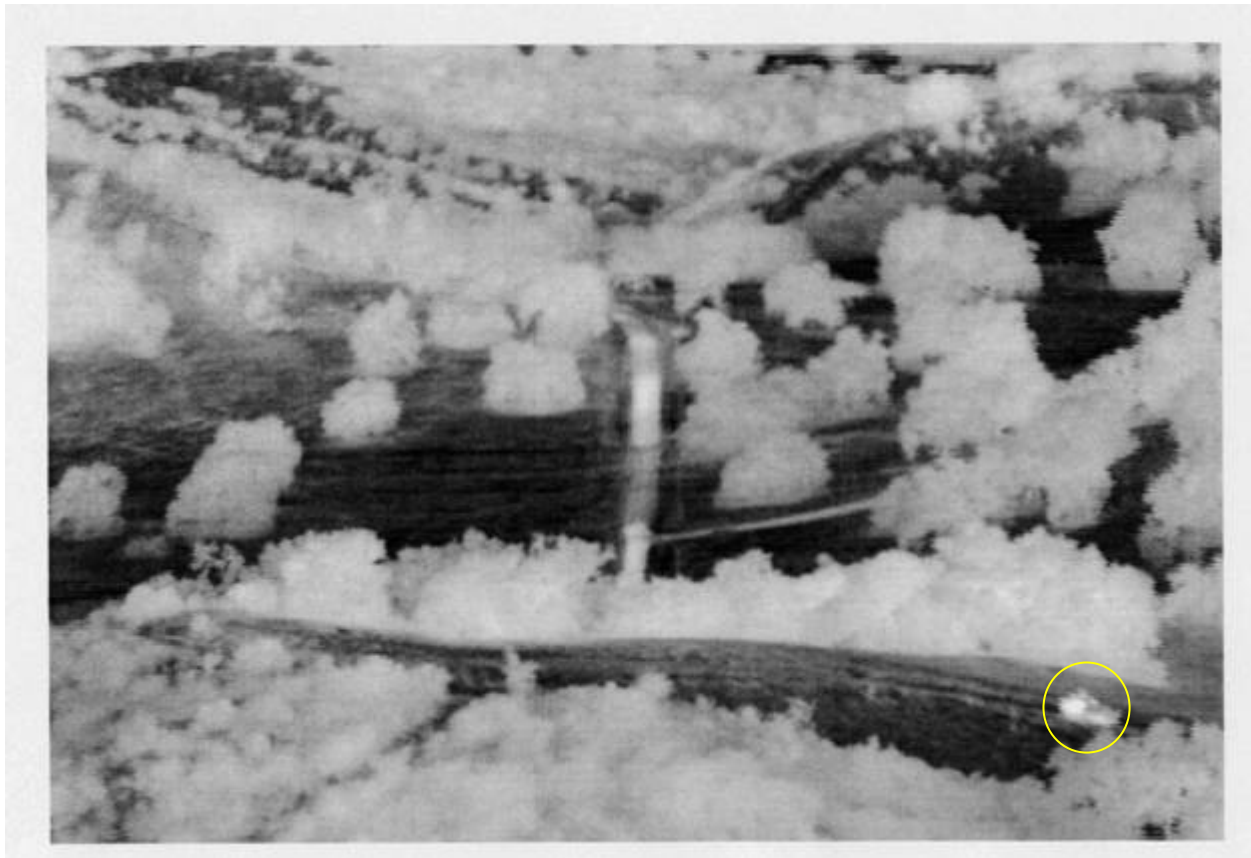
AGEMA FLIR Imagery, No Camouflage, Left Side ,1 KM





LAV-25

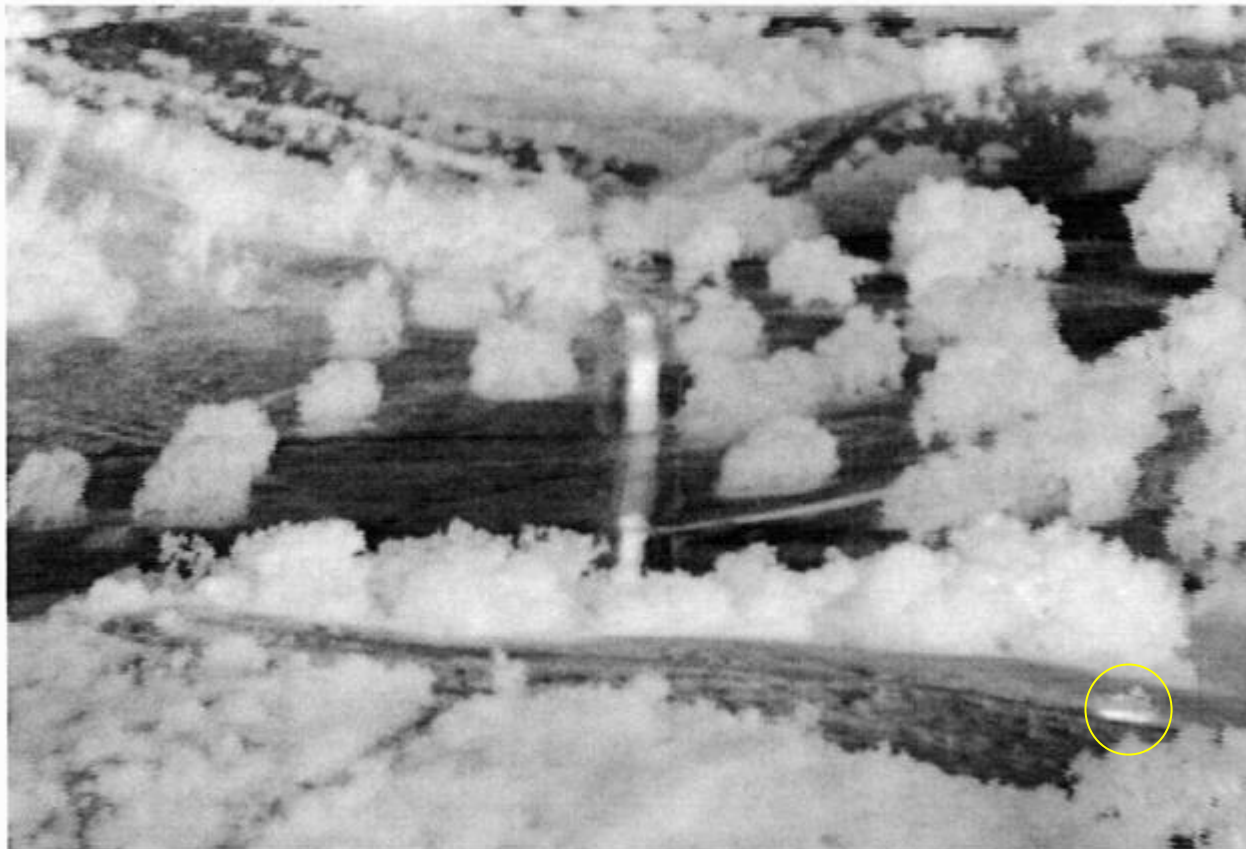
AGEMA FLIR Imagery, Depot Level Camouflage, Right Side ,1 KM





LAV-25

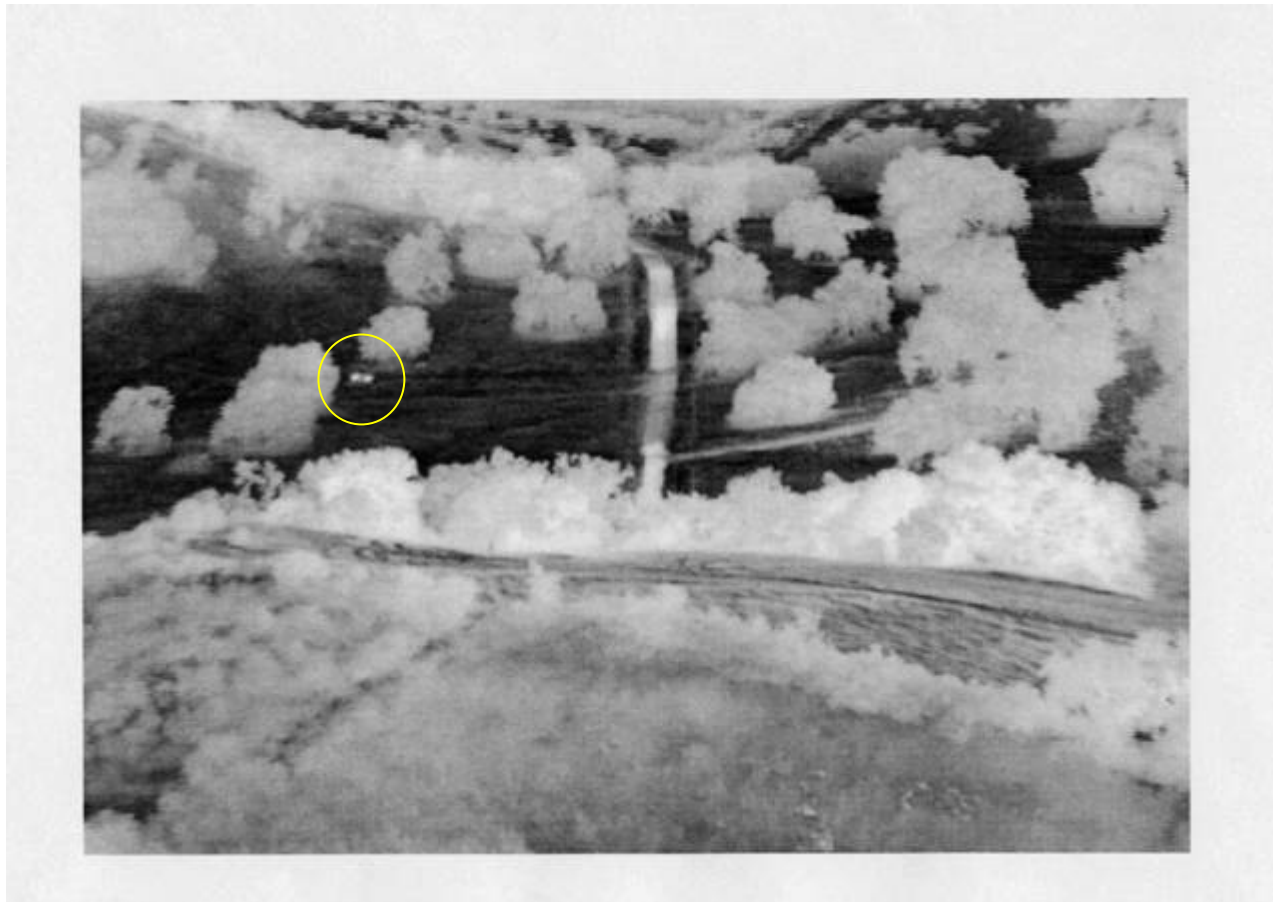
AGEMA FLIR Imagery, Depot Level Camouflage, Left Side ,1 KM





HMMWV

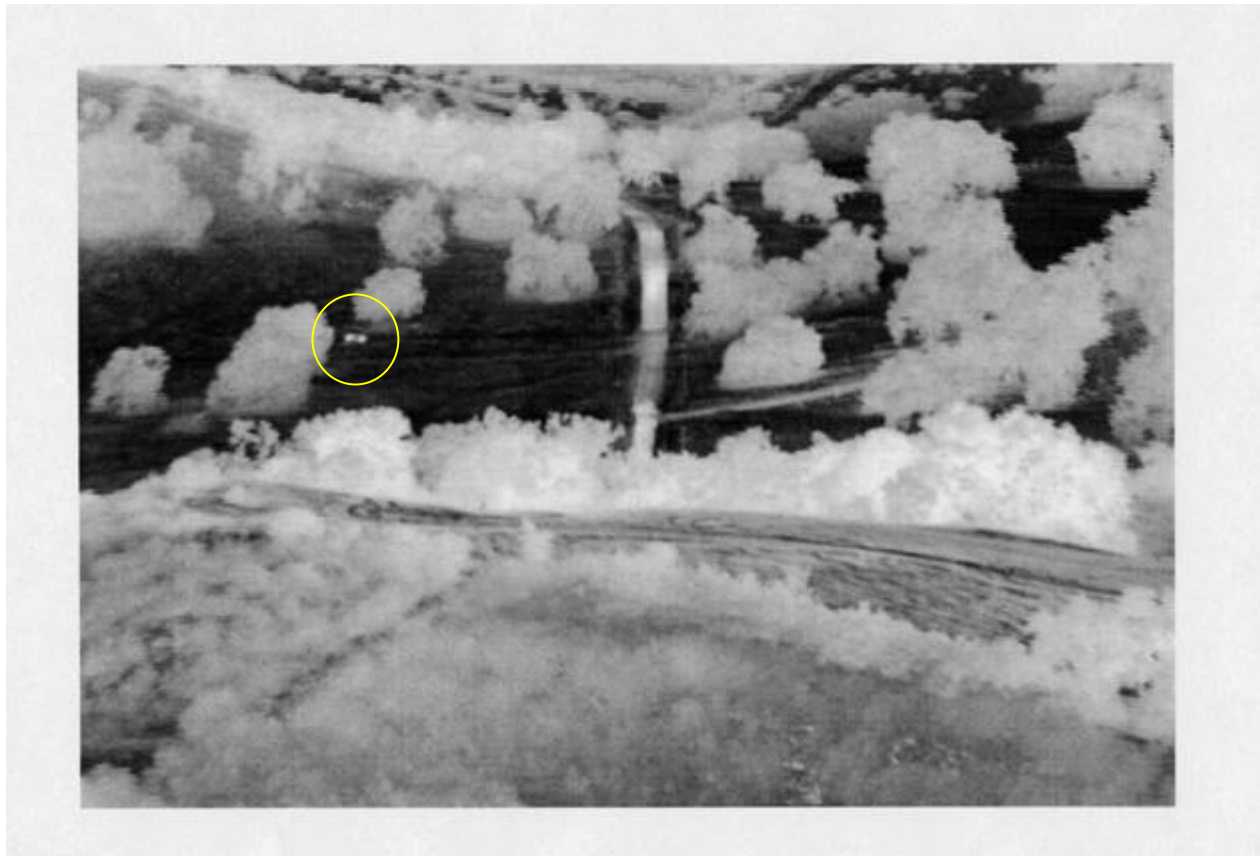
AGEMA FLIR Imagery, No Camouflage, Right Side, 1 KM





HMMWV

AGEMA FLIR Imagery, No Camouflage, Left Side, 1 KM





HMMWV

AGEMA FLIR Imagery, Depot Level Camouflage, Right Side, 1 KM





HMMWV

AGEMA FLIR Imagery, Depot Level Camouflage, Right Side, 1 KM





Conclusions

- Simple camouflage techniques can result in making the vehicle targets more difficult to detect, through the Long wave FLIR systems.
- The conveyer belt material is rugged and can survive field use. The conveyer belt material is successful in reducing the infrared signature cues from the tracks, tires and wheel hubs. This camouflage may be even more effective in cold and wet weather conditions.
- This camouflage is simple to use and easy to install. Its effectiveness is enhanced if the installing crew uses a FLIR camera to verify that the camouflage is hiding all the very hot parts, such as the engine exhaust, engine intake, tracks, road wheels and wheel hubs. On site personnel reported that the conveyer belt material reduced the sound level of the test vehicles. Sound measurements conducted with and without the conveyer belt camouflage confirmed that there is a reduction in the sound volume but not the inherent signature.
- Field expedient camouflage with camouflage netting is effective if the hot spots can be eliminated. The use of pieces of camouflage netting helps in visually camouflaging the vehicle.
- Field expedient and depot level camouflage is within the technological capability of practically any 3rd world country.



Additional Slides

Examples of Foreign Mobile Camouflage Kits



Foreign Mobile Camouflage Systems



**Swedish
Barracuda
Camouflage Kit on
LAV-25
Pre-test
Post-test**





Foreign Mobile Camouflage Systems

GE Texplorer Camouflage Kit on Leopard II Tank at German Test Range



Unclassified



Foreign Mobile Camouflage Kit

**GE Texplorer
Camouflage Kit on
M2A2 Bradley at a
US facility in GE**

Unclassified



Unclassified

**GE Texplorer
Camouflage Kit on
M2A2 Bradley at
US test site**



Foreign Mobile Camouflage Kit

UK Colebrand Camouflage Kit on M2A2 Bradley at US Test Site



Unclassified